

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
15 September 2005 (15.09.2005)

PCT

(10) International Publication Number  
**WO 2005/086241 A1**

(51) International Patent Classification<sup>7</sup>: **H01L 33/00**

(21) International Application Number:  
PCT/JP2005/004138

(22) International Filing Date: 3 March 2005 (03.03.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
2004-060585 4 March 2004 (04.03.2004) JP  
60/553429 16 March 2004 (16.03.2004) US

(71) Applicant (for all designated States except US): **SHOWA DENKO K.K.** [JP/JP]; 13-9, Shiba Daimon 1-chome, Minato-ku, Tokyo 105-8518 (JP).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **KOBAYAKAWA, Masato** [JP/JP]; c/o Showa Denko K.K., 5-1, Yawata

Kaigan dori,, Ichihara-shi, Chiba 290-0067 (JP). **TO-MOZAWA, Hideki** [JP/JP]; c/o Showa Denko K.K., 5-1, Yawata Kaigan dori,, Ichihara-shi, Chiba 290-0067 (JP). **MIKI, Hisayuki** [JP/JP]; c/o Showa Denko K.K., 5-1, Yawata Kaigan dori,, Ichihara-shi, Chiba 290-0067 (JP).

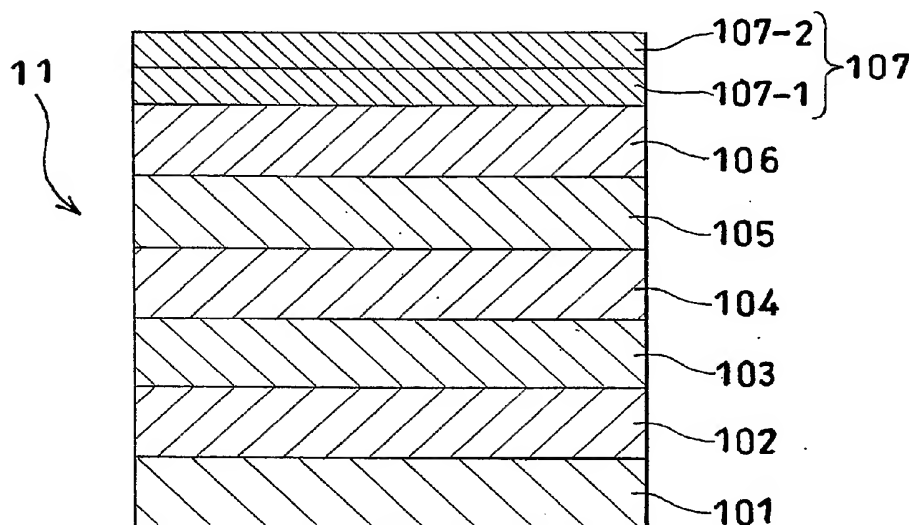
(74) Agents: **FUKUDA, Kenzo** et al.; Kashiwaya Bldg., 6-13, Nishishinbashi 1-chome, Minato-ku, Tokyo 105-0003 (JP).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: GALLIUM NITRIDE-BASED SEMICONDUCTOR DEVICE



(57) Abstract: A gallium nitride-based semiconductor device has a p-type layer that is a gallium nitride (GaN) compound semiconductor layer containing a p-type impurity and exhibiting p-type conduction. The p-type layer includes a top portion and an inner portion located under the top portion. The inner portion contains the p-type impurity and, in combination therewith, hydrogen. The top portion includes a region containing a Group III element and a Group V element at a non-stoichiometric atomic ratio.

WO 2005/086241 A1



European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**Published:**

— *with international search report*